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2589

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Requestor — Document Center (is requested to provide the following document)

Date of request 2/16/96 — Expected receipt of document 3/16/96

Document number KS-331 — Date of document 11/29/52

Title and author (if document is unnumbered)

(This section to be completed by Document Center)

Date request received 2/20/96

Date submitted to ADC 2/21/96

Date submitted to HSA Coordinator 2/20/96

(This section to be completed by HSA Coordinator)

Date submitted to CICO 2/21/96

Date received from CICO 3/6/96

Date submitted to ChemRisk/Shonka and DOE 3/6/96

(This section to be completed by ChemRisk/Shonka Research Associates, Inc.)

Date document received

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SECURITY INFORMATION

CARBIDE AND CARBON CHEMICALS COMPANY
A DIVISION OF UNION CARBIDE AND CARBON CORPORATION
UCC
POST OFFICE BOX P
OAK RIDGE, TENNESSEE

K-S-331
PRD-1

November 29, 1952

United States Atomic Energy Commission
Post Office Box E
Oak Ridge, Tennessee

Attention: Mr. Ray C. Armstrong, Director, Production Division

Gentlemen:

Report of Release of K-25 Process Materials

The attached report of the formal investigation of a serious incident involving the release of K-25 process materials has been prepared in accord with our obligations to investigate and report such incidents as specified in Bulletin OR-SFP-5 (Serial No. 88). The actions which have already been taken and those which are proposed for completion appear to encompass major practicable precautions against the future occurrence of similar incidents.

Yours very truly,

CARBIDE AND CARBON CHEMICALS COMPANY

A. P. Huber

K-25 Plant Superintendent

HFH:lja

cc: Mr. C. E. Center
Mr. W. B. Humes
Mr. W. L. Richardson

INVESTIGATING COMMITTEE REPORT

OF SERIOUS INCIDENT

INVOLVING RELEASE OF K-25 PROCESS MATERIALS

KS-331

Description of Damaged Property: Shell of a Size 1, Kellex-Type Cold Trap. Casing of 5-Stage Recirculating Pump.

Amount of UF_6 Released to Atmosphere: Approximately 50 lb. of normal UF_6.

Time of Incident: 12:10 a.m., October 6, 1952

Location of Incident: Cold Trap Room, K-1131 Feed Plant, Carbide and Carbon Chemicals Company, K-25 Plant, Oak Ridge, Tennessee.

Description of Incident: During the normal heating of a Size 1, Kellex-Type Cold Trap in the K-1131 Feed Plant for the purpose of vaporizing UF_6 to be used as plant feed, a small rupture of the outer wall of the cold trap occurred, resulting in the release of approximately 50 lb. of gaseous UF_6 to the atmosphere. The trap was immediately vented to the recycle system, the calrod heaters shut off, and the trap CO_2 cooling system was activated to freeze the material remaining in the trap. The release stopped in less than a half-hour, but final settling of the material released required an additional half-hour. As a result of the increased pressures in one of the recycle pumps, a gasket was forced out and a fire started by the reaction of the hydrocarbon pump oil with a small amount of fluorine in the system. The fire was brought under control by use of CO_2 extinguishers by the time the principal hazard due to the material release had ceased.

Findings:

1. The operations at the time of the release were as follows:

   (a) Normal operation requires alternate heating of the trap and the draining of the liquid UF_6. The trap had been partially drained during the preceding shift, and the drain procedure was continuing with the trap being heated at the time of the release.

   (b) The trap was being operated under usual conditions at a skin temperature of approximately 290°F. and a pressure of 45 psig. as shown by trap instrumentation.

(c) A cold trap operator was at the control station preparing to connect another filled trap to the feed line. When he saw that material was escaping from the ruptured unit, he disconnected the heaters, vented the trap to the recycle system, valved in the CO_2 cooling system, and evacuated.

(d) The evacuation alarm was sounded from the control room and employees were immediately evacuated from the building.

2. The abrupt release of the gaseous contents of the trap to the recycle line forced out a gasket and seal of one of the recycle pumps, permitting the hydrocarbon oil used for lubrication to come in contact with the small amount of fluorine which is normally in the recycle system. The resultant reaction produced a fire which burned off the insulation of the pump control wiring and damaged other parts of the pump. The Fire Department was called to deliver additional large CO_2 fire extinguishers to this location and to give standby assistance while the fire was extinguished by the operators using CO_2.

3. The following information concerning the present use of the cold trap is considered significant:

(a) This trap was one of those which was originally designed to be used for cascade purging operations. With this type of operation, material would normally have accumulated slowly as a result of process difficulties, and its subsequent release back to the cascade would also have been at a slow rate. Thus, these units were designed for an operating temperature of 160°F. (176°F. skin temperature) and a 40 psig. operating pressure.

(b) The original "triple-pass" design of the cold trap called for heating units inside the trap as shown on the attached diagram of the cross section of the trap. However, as a result of the recent increased use of these heaters in phase II of Feed Plant operations, the plant reserve has been exhausted, and although additional heaters of this type have been on order since November 1951, none have been delivered as the original vendor has now encountered difficulty in meeting the specifications. Thus, in September 1952 it became necessary to devise a substitute heating method which involved doubling the number of heating units placed outside the trap.

(c) On September 5, 1952, before installation, the trap which failed was given the specified pressure test, which included a 60 psig. air test of the shell.

4. The present heating cycle requires approximately 4 to 5 hours to remove all of the contents of a filled trap. Under normal operation, a trap will receive the manufactured feed until it plugs, at which

time it will contain approximately 1200 lb. of UF_6. It is then heated so that the condensed UF_6 is liquefied and this liquid is then drained.

5. Comments concerning available relief devices are as follows:

   (a) As installed, the trap has a relief valve and a safety diaphragm connected in series between the trap and a surge drum. However, the safety diaphragm had previously failed, indicating a previous pressure difference between the trap and the tank greater than about 45 psig. although corrosion of the diaphragm disc, which is not uncommon, could have permitted failure at a lower pressure. After failure of the diaphragm, the relief valve had been observed to leak; thus, both the valve and the diaphragm had been blocked from the system. Although this particular action was directly contrary to plant policy for normal operations, it was not considered to be a direct factor in the cause of this specific incident.

   (b) The safety diaphragms on the surge tank were designed for a maximum pressure of 50 psig. with respect to the atmosphere. Thus, if the pressure in the tank were 10 psi. above atmosphere, a pressure in the trap of 55 psi. above atmosphere would be needed to rupture a safety diaphragm set for 45 psig. On this basis, it would then be at least theoretically possible to have a 50 psig. pressure in the surge tank and a pressure in the trap of approximately 95 psi. above atmosphere without rupturing the trap safety diaphragm. However, pressures in the surge tank above a few psig. would have required both the failure of the pressure-regulated temperature controller of the tank heating system and a much larger tank inventory than normal.

   (c) Overpressure alarms were available. However, due to frequent operation above the alarm pressure of 40 psig., these had been made ineffective.

6. The rupture consisted of a 1-1/2" long longitudinal crack under one of the clips holding one of the original calrod heating units close to the trap surface. Although the original specification had required a thermal insulator between the calrod unit and the clip, such insulation had not been applied in this case. Also, the clip was designed to hold the heater approximately 9/16" from the trap surface, but inspection at the time of discovery of the crack indicated that in some way it had been so pinched that the calrod was in contact with the trap shell. The description of the calrod units included a surface temperature specification of about 500°F.

7. No significant deformation of the trap shell was noted at the site of the rupture.

8. Photomicrographs of the trap shell near the site of the actual rupture indicated that the break itself was a high temperature stress rupture, and there were indications that the conditions leading to this rupture had developed as a result of overheating over an extended period of time.

9. Fourteen employees involved in the release were sent to the dispensary for supervisory checks, but no clinical evidence of injury due to this incident was observed.

10. The material remaining in the cold trap was removed during the next few days after the incident.

Conclusions:

The committee considered the primary cause of the ruptured cold trap to be failure of the metal as a result of continuous operation at temperatures and pressures above those for which it was designed. The accompanying motor fire was considered to be due to the reaction of fluorine and hydrocarbon oil, the mixing of these substances being directly due to the cold trap failure.

Recommendations:

As a result of recommendations made by the committee investigating this incident, the actions outlined below have either been taken or are planned in order that the possibility of a future occurrence of this type be reduced as far as practicable.

Action Taken to Prevent Future Incidents of This Type

1. The time cycle involved in draining the contents of a trap to a cylinder has been increased by reducing the maximum allowable skin temperature from 290°F. to 275°F. and thus decreasing the rate of heat input to the traps. Although this temperature is still considerably above the design skin temperature, it does not appear practicable to reduce it still further at this time.

2. Appropriate action has been taken to insure that design specifications are being met during all maintenance operations on these traps.

3. Heating of the traps will not be started unless the pressure relief devices are effective and alarms are operable. Although the condition of relief devices and alarms in this instance are not considered to have been causes of the incident, this provision will insure closer adherence to plant policy of having equipment adequately protected during normal operation.

Remaining Action to be Taken to Correct Conditions

1. The design of a cold trap capable of meeting the temperature and pressure cycle requirements of production operations will be completed, and a sufficient quantity of these units will be procured to fulfill plant needs. Such a trap is now being tested.

2. The cold trap-surge tank system will be so modified that pressure relieving devices do not permit pressures either in the tank or the trap to exceed the specified maximum allowable working pressures of these units. In particular, efforts will be made to so modify the tank relief devices that the pressure therein will not exceed 10 psig.

INVESTIGATING COMMITTEE

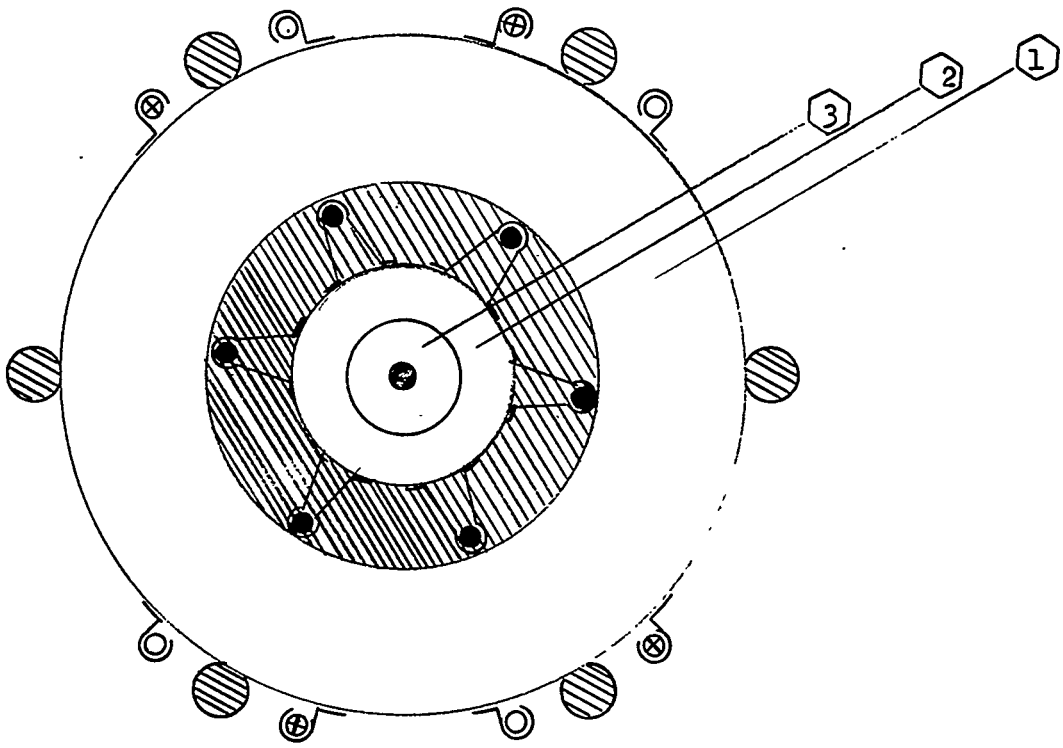
B. H. Thompson, Chairman,
Chemical Operation Department Head

for W. J. Hamer, Member,
General Engineering Department Head

G. S. Storer, Member,
Mechanical Inspection Department Head

H. F. Henry:lja

CROSS SECTION VIEW OF COLD TRAP



Legend

- ○ Heaters normally available
- ● Location for unavailable heaters
- ⊕ Substitute heaters
- Shaded oval: CO_2 used as coolant
- (1)(2)(3) Space for condensing UF_6
- Note: Heater and cooling tube are inside #3 UF_6 space